M/045/017

DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH

Norman H. Bangerter
Governor
Suzanne Dandoy, M.D., M.P.H.
Executive Director
Kenneth L. Alkema
Director

288 North 1460 West
P.O. Box 16690
Salt Lake City, Utah 84116-0690
(801) 538-6121

RECEIVED
OCT 19 1989
DIVISION OF
OIL, GAS & MINING

DOGM
MINERALS PROGRAM
FILE COPY

October 16, 1989

Mr. Frank Wicks, V.P., Gen. Manager
Barrick Mercur Gold Mine
P.O. Box 838
Tooele, Utah 84074

Re: August 28, 1989 Report: Seepage and Ground Water Assessment for Dump Leach Area 2, Barrick Mercur Gold Mine, Utah for Barrick Resources (USA) Inc.

Dear Mr. Wicks:

We have reviewed the above mentioned report and met on site with your staff regarding Dump Leach No. 2. Our comments are attached.

Please modify the groundwater monitoring plan for Dump No. 2 in accordance with the attached comments. If you have any questions, please call Loren Morton at 538-6146.

Sincerely,

Don A. Ostler

Don A. Ostler, Director
Bureau of Water Pollution Control

Attachment

cc: Terry Vandell, Dames & Moore
Scott Matheson, Parsons, Behle & Latimer
Stephen Matern, Tooele County Health Dept.
Wayne Hedberg, DOGM
Glade Shelly, Utah County Health Dept.

LBM:kc
BMDUMP2

Seepage and Ground Water Assessment for Dump Leach Area 2,
Barrick Mercur Gold Mine Utah for Barrick Resources (USA), Inc.
Dated August 28, 1989

Bureau of Water Pollution Control Comments

Geology (pp.1-6)

1. Local Geology (p. 6) - the Upper Member of the Great Blue Formation could extend to a depth of 1,100 ft. or more particularly on the east side of Dump No. 2, not 700 ft as reported (see Tooker, USGS Open File Report 87-152, sheet 3, Cross-Section B-B':)

Hydrogeology (pp. 6-13)

1. General (pp. 6-7)

    a. Manning Spring (p. 6) - though the Manning Spring is topographically lower than Dump 2, it is separated hydrogeologically by the Manning Canyon Shale, a highly bentonite shale formation, over 1100 ft thick (Tooker, USGS Open File Report 87-152, p. 9). Therefore, the Manning Spring is likely found in a different ground water flow system, and not hydrologically downgradient of Dump No. 2.

    b. Seep/Spring Inventory (p. 7) - no survey of seeps or springs in the Manning Canyon area has been provided to support the claim that none exist. This is particularly important along the west side of the canyon where groundwater near Dump No. 2 may flow. Any such springs or seeps may be useful in monitoring ground water impacts from Dump No. 2. Barrick should undertake such an inventory to compliment any monitoring well network.

2. Ground Water Occurrence and Use (pp. 7-9)

    a. Wells CD-4, 4A, and 4B (p. 7) - low yields reported in pump testing for wells CD-4, 4A, and 4B may have been a factor of well completion, and yet are still within a useful range for groundwater monitoring. Unfortunately, these wells have been plugged and abandoned.

    b. Manning Spring (p. 8) - it is very unlikely that Manning Spring receives any recharge from the Dump No. 2 area. Refer to Comment 1 (a) above.

    c. Barrick Downgradient(?) Water Well (p. 9) - as stated by your staff on September 13, 1989, the Barrick water supply well which corresponds to Utah Water Rights No. 15-2858, (see Table A-1, p. 10) has been abandoned, since the water right lapsed in 1984. This well may have been named GC-20 or GB-19, but has since been covered by the Marion Hill Pit access road. Consequently no wells currently exist in proximity to Dump No.2.

3. Groundwater Flow Regime (p. 10)

   a. Groundwater Flow Boundaries - it is anticipated that the groundwater flow system which Dump No. 2 is found in would be bounded on the east by the Manning Canyon Shale and likely at depth by the Long Trail Shale. Barrick may be able to produce geologic cross-sections or fence diagrams from drill holes completed nearby for mineral exploration which may further define the boundaries of the ground water flow system.

   b. Groundwater Flow Direction - if flow is to the east-northeast, how then does Barrick explain the lower water level elevations (355 ft) found approximately 1150 ft southwest of Dump No. 2 in Well CD-4B? Groundwater flow may be in a southerly direction. To resolve the ambiguity, Barrick will need to drill at least two wells, and perhaps more, to demonstrate that the wells to be used for monitoring are hydrologically downgradient of Dumps No. 1 and 2.

4. Ground Water Quality (pp. 11-12)

   a. Monitoring Wells TMW-1 and 2 - These wells appear to be located in a different ground water flow system, therefore water quality data from them is not directly related to Dump No. 2.

<u>Dump Leach Area #2</u>

1. Seepage Estimates (pp. 17-21)

   a. Potential Seepage Pathway (p. 17) - because the Manning Canyon Shale appears to form a significant flow barrier between Dump No. 2 and the Manning Spring, it is unlikely that Manning Spring could be a potential discharge location for Dump No. 2 seepage.

2. Water Balance (p. 18-19) - No catastrophic seepage has been detected through an assessment of flows in and out of Dump No. 2. Any efforts to refine these calculations would need to account for:

   a. Precipitation onto Dump No. 2, including its episodic nature.

   b. Evapotranspiration of fluid from the surface and interior of Dump 2.

Based on the water balance accuracy you reported of 10-20%, the seepage losses, if they exist, should be less than 69-138 gpm.

3. Hydraulic Calculations (pp. 19-22) - we agree with the clay liner seepage calculations presented. The seepage estimates for the most conservative case (current operating conditions) of 0.23 gpm equates to a 331 gal/day discharge to ground water, still a significant volume of fluid considering the nature of the potential contaminants.

4. Chemical Interactions and Attenuation of Contaminants (pp. 22-25)

   a. Drinking Water/Ground Water Quality Standards (p. 22-23) - after review of tailings pond water quality data from your June 9, 1989 submittal, it is obvious that the barren solution applied to the dump, also exceeds State Drinking Water Standards (UAC R449-103-1.1) for nitrate (10 mg/l, NO_3as N) and may exceed the standard for lead (0.05 mg/l).

   b. State Ground Water Quality Standards - are applicable to ground water beneath Dump No. 2. These standards include (UAC R448-6-2):

Parameter	Ground Water Quality Standards (mg/l)
Nitrate (as N)	10.0
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Copper	1.0
Lead	0.05
Mercury	0.002
Selenium	0.01
Silver	0.05
Zinc	5.0

   The above Ground Water Quality Standards and/or background concentrations will be used to determine compliance for the ground water beneath Dumps Nos. 1 and 2. Any noncompliance will require further investigation and resolution.

   c. Cyanide Compliance Standards for Ground Water - No drinking water standards have been established by EPA for cyanide, due to its rare occurrence, nationally, in raw water sources for drinking water supply. No state Ground Water Quality Standards have been set by the Utah Water Pollution Control Committee. However, pursuant to UCA Section 26-11-8, it is incumbent on the Bureau to set a site specific limit of cyanide concentration for ground water at your facility that will protect human health, and the environment. Site specific ground water limits can also be determined by the Executive Secretary in the course of issuing a Ground Water Discharge Permit, where no ground water standard exists for a discharged pollutant [UAC R448-6-6.4(c)(1)]. In accordance with the provisions of UAC R448-6-6.1(B) we anticipate your facility will be required to make application for such a permit in the near future.

Because your facility is located in the recharge area of the aquifer that supplies drinking water to the community of Fairfield, EPA drinking water health advisories (recommend limits) are applicable to your case. Based on the review of EPA's health advisory for cyanide, consultation with EPA staff, and review of ground water quality requirements for cyanide leach operations from neighboring states, we have determined the following ground water quality limit is applicable to your facility:

200 ug/l Weak Acid Dissociable (WAD) Cyanide.

This limit will be used as a site specific ground water quality standard to determine the compliance of your facility. We expect it will apply to ground waters beneath Dumps Nos. 1, 2, and 3, and the tailings pond. This compliance standard may be changed at some future date, if:

1. EPA promulgates a drinking water standard which differs from 200 ug/l WAD cyanide, or

2. The Utah Water Pollution Control Committee promulgates a ground water quality standard for cyanide which differs from the value above.

d. WAD Cyanide Analysis Methods - acceptable WAD cyanide analysis methods include:

1. Method C, Weak Acid Dissociable Cyanide, D2036-082, Part 31 of the American Society of Testing Materials Book of Standards.

2. Method 412H, Weak and Dissociable Cyanide, of Standard Methods for the Examination of Water and Wastewater by the American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 16th Ed.

Both methods should utilize a colorimetric finish in order to achieve an acceptable detection limit (30 ug/l). Other equivalent methods may be used, but must receive prior approval from the Bureau.

e. Metal-Cyanide Complexes (p. 24) - The mobility of metal-cyanide complexes thru clay materials, mentioned in the report, is more support for the analysis of dissolved metals in ground water monitoring.

f. Contamination Indicators (p. 24) - Sulfate and sodium are conservative contaminants, very mobile in most ground water flow systems, and are predominant in the barren solution applied to Dump No. 2. They are also not common to carbonate ground water flow systems, and hence may be good pollution indicators. Other contamination indicators may include:

   1. Cyanide - total, WAD, and free.

   2. Cyanide Degradation Products - cyanate, thiocyanate, ammonia, nitrate and nitrite.

   Stable isotopes, such as Sulfur-34, Nitrogen-15, or others may also be helpful as contamination indicators.

5. Subsurface Monitoring (pp. 25-26)

   a. Monitoring Well Location - we agree with the reports conclusion that ground water flow beneath Dump No. 2 is thru fractures in the limestone foundation. Consequently, an analysis of faults and joints should be considered in the placement of monitoring wells. We agree with your consultants suggestion of placing the first deep well east of Dump No. 2, in that in the general vicinity three faults are known to exist (Tooker, USGS Open File Report 87-152, Sheet 2).

   b. Lysimeters - lysimeters cannot replace monitoring wells at Dump No. 2 for the following reasons:

      1. Lysimeters have a very limited area of influence. Consequently, they cannot monitor but a very small area in proximity to borehole.

      2. In the case of Dump No. 2, the lysimeter would intercept a dry fracture(s) in the limestone. Without evidence that the fracture(s) is hydraulically connected to the base of Dump No. 2, it is impossible to ascertain the adequacy of the monitoring point. Though the same may be true of a monitoring well completed into a saturated fracture, fewer unknowns exist. Local hydrogeology dictates that the ground water flow system in proximity to Dump No. 2 is recharged by direct precipitation at the ground surface. Therefore, any water found in the fractures of the Upper Member of the Great Blue Formation came from recharge at the surface, where Dump No. 2 is also located.

   As a consequence, an approvable ground water monitoring network will not include lysimeters, but will be based on monitoring wells.

c. Shallow Monitoring Wells - the shallow monitoring wells proposed are based on a conceptual model that perched ground water exists, primarily in alluvial deposits, as found once in a water supply exploratory well, WW-2. While such perched water may exist, it is highly unlikely that it is very extensive, laterally or vertically, due to:

1. The highly fractured nature of the limestone bedrock in the vicinity of Dump No. 2 which would allow infiltration to greater depths, and

2. The limited outcrop of alluvium, as displayed on Tooker's geologic map (USGS Open-File Report 87-152, Sheet 2).

Though it is your prerogative to explore for shallow zones in development of a ground water monitoring network, Barrick must be prepared for the contingency to complete deep wells in order to provide an adequate monitoring well network. Also, any zone of saturation proposed for downgradient ground water monitoring must be found at a lower elevation than the lowest point of the clay subbase beneath Dump No. 2.

d. Upgradient and Downgradient Monitoring Wells - Of the contamination indicators mentioned in Comment 4(f) above, the cyanide degradation products including ammonia, nitrate, and nitrite are all naturally occurring contaminants. Consequently, at least one (1) upgradient monitoring well will be required, in order to establish background concentrations of these contaminants and allow adequate evaluation of any ground water impact caused by Dump No. 2. At least one (1) downgradient monitoring well will also be required. However due to field conditions beyond our control, Barrick should be prepared to install more wells, as necessary, to adequately demonstrate that the monitoring wells are hydrologically up and downgradient of Dumps No. 1 and 2.

<u>Appendix A: Well and Spring Inventory and Water Quality Data</u>

1. Fairfield Spring Water Quality Analysis - A quality assurance problem exists for a sample collected by Barrick on June 21, 1989. The bicarbonate content reported(338 mg/l) was higher than the total dissolved solids content(298 mg/l).

Appendix E: Long Trail Shale Geochemical Evaluation

1. Ground Water Discharge Compliance - Information found in Tables 6 and 7 demonstrated the cyanide attenuation capacity of the Long Trail Shale under 30 foot heads, comparable to current operating conditions, summarized below:

Soil Column Length	Pore Volumes	Equivalent Liner Thickness	Cyanide Concentration Passing	
			Total CN	WAD CN
3 inches	8.55	25.65 inches	68.4%	72.6%
6 inches	4.06	24.36 inches	13.2%	15.2%*

* The consultant estimated a 20% passing concentration of WAD CN, after consideration of anomalous test results (p.21).

Focusing on the results of the six inch column and assuming a 250 mg/l WAD cyanide content of the fluid applied to the clay, one can estimate the cyanide concentration of the fluid which may escape the clay liner, as follows:

$$\text{WAD CN} = 250 \text{ mg/l} \times 0.152 = 38.0 \text{ mg/l}$$

As can be seen, the total cyanide concentration of the effluent escaping the clay liner may be as high as 190 times the ground water compliance standard of 200 ug/l applicable to Dump No. 2. If we use the consultants estimate of 20% passing WAD cyanide, the cyanide content of the clay liner effluent jumps to 250 times the ground water compliance standard for cyanide. This information reinforces the need for an adequate monitoring well network for Dumps No. 1 and 2.

2. Solution Chemistry Results - Free cyanide analyses conducted by Chemtech of barren, pregnant, and leak collection fluids collected on August 3, 1989 are inconsistent with results of sampling provided by the consultant on pages 3 and 4. No explanation has been provided.

Appendix F: Proposed Subsurface Drilling and Monitoring Program

1. Lysimeters (p. F-2) - same concerns as in comments above. Only monitoring wells completed in saturated zones will be acceptable.

2. Up and Downgradient Wells (p. F-2) - the location and placement of monitoring wells can only be determined after the potential contaminant flow path is determined through evaluation of the local hydrogeology, ground water flow directions, and other hydrologic data. Barrick must be prepared to confirm and ascertain through such hydrologic data that the monitoring wells are truly up and downgradient of Dumps No. 1 and 2. This could result in the drilling of multiple deep wells in order to obtain the necessary hydrologic information.

3. Well Logging (pp. F-2 - F-3) - geologic logging should include logs made by a trained geologist describing lithologic, stratigraphic, mineralogic, paleontologic, hydrologic, drilling and sample recovery conditions. Geophysical logging should be supervised and logs interpreted by a trained log analyst. A driller's log should also be maintained describing general types of earth materials encountered, types of drilling equipment, drilling fluids, methods and conditions, penetration rates and circulation losses.

4. Perched Ground Water in Deep Wells (p. F-3) - shallow water bearing intervals in deep wells should be cased and grouted, regardless of the shallow water quality, to prevent vertical intercommunication that can render water quality samples and piezometric elevation data unrepresentative. This isolation should not be contingent on the shallow zone being contaminated, which is hard to determine in the short time frames required by most field operations.

5. Length of Screen - the length of screen should be limited as much as possible, so as to prevent any averaging of piezometric head. Screen length from well to well should also be equal in order to allow comparison of piezometric head or ground water flow directions, and gradients.

6. Well Development - well development should continue until the purged ground water has a turbidity content of less than 5 NTU.

7. Monitoring Well "As-Built" Report - after completion of the monitoring wells, an "as-built" report should be submitted to document the well construction. Information that should be included is as follows:

   - Date/time of construction
   - Drilling method and drilling fluid used
   - Well location (± 0.5 ft.)
   - Bore hole diameter and well casing diameter
   - Well depth (± 0.1 ft.)
   - Drilling, geologic, and geophysical logs
   - Casing materials
   - Screen materials and design
   - Casing and screen joint type

- Screen slot size/length
- Filter pack material size, and grain analysis (granular aquifers)
- Filter pack placement method
- Sealant materials (percent bentonite)
- Sealant volume (lbs/gallon of cement)
- Sealant placement method
- Surface seal design/construction
- Well development procedure
- Type of protective well cap
- Ground surface elevation(± 0.1 ft)
- Surveyor's pin location and elevation on concrete apron(± 0.1 ft)
- Top of monitoring well casing elevation(± 0.1 ft)
- Top of protective steel casing elevation(± 0.1 ft)
- Detailed drawing of well (include dimensions)

As a reminder, the State Engineers Office reguires a Notice of Intent for all monitoring wells installed.

8. Hydraulic Conductivity Testing - hydraulic conductivity testing is essential to determining interconnection between up and downgradient wells, ground water velocity, and data for use in ground water modeling efforts. This testing should be conducted after well or monitoring network completion. Acceptable testing methods include:

    a) Piezometer tests (slug or bail tests)

    b) Pump tests (ex. Theis, Jacob, or Papadopulus and Cooper methods)

    c) Well Specific Capacity (if saturated thickness and storage coefficient are known).

9. Ground Water Sampling - should also include:

    a) Sample Filtration - in the field before preservation to allow for analysis of dissolved metals. Appropriate filter media conclude: cellulose nitrate, cellulose acetate, polycarbonate, or Teflon. Glass fiber filters may be used if prerinsed with an acid (0.1 N HC1) and distilled water. Recommended filter pore size is 45 micron.

    b) Decontamination - any sampling equipment carried from well to well which contacts water samples should be decontaminated before the next sampling episode. At a minimum, decontamination should include:

        1) An initial rinse with a detergent solution.

        2) A final rinse with distilled water.

c) Sample Holding Time - holding time for samples, from time of collection to time of analysis can not exceed the EPA requirements of 40 CFR 136.3(e). In the case of nitrate, analysis will need to be conducted within 48 hours of sample collection.

d) Field Equipment Calibration - equipment used to measure field parameters, pH, temperature, conductivity should be calibrated before each round of sample collection; at least daily.

e) Field Data Reporting - data collected in the field associated with sample collection should be attached with the laboratory results for each water sample. This field data should include:

1) Well name or number.

2) Date of sampling.

3) Well depth and inside diameter.

4) Names of sampling crew.

5) Water level measured in well before sampling, and calculated well casing volume.

6) Time pump is turned on and off.

7) Pumping rate and volume of water purged.

8) Time of sampling.

9) Field parameters measured from ground water sample: pH, temperature, and conductivity.

A pre-prepared form may facilitate this record keeping for your field personnel.

f) Sample Collection - we recommend upgradient monitoring wells be sampled before downgradient wells, in order to minimize any cross-contamination.

10. Analytical Laboratory - Chemtech, the laboratory you proposed is <u>not</u> certified by the Utah State Health Laboratory (SHL) for the following parameters (July 10, 1989 SHL Certification*):

Barium	Carbonate
Bicarbonate	Magnesium
Boron	Nitrite
Calcium	

* Certification scheduled to expire on January 5, 1990.

Chemtech is provisionally certified for (July 10, 1989, SHL Certification*):

Arsenic
Hardness**
Specific Conductivity

* Provisional certification means that it is possible that Chemtech may lose SHL certification for these parameters at the time of the next SHL audit.

** all hardness tests: as $CaCO_3$,HCO_3 noncarbonate, and total.

Analyses of all the ground water monitoring parameters need to be conducted by a SHL certified laboratory(s). Analyses conducted by laboratories not certified by the SHL for those parameters will not be accepted by the Bureau for the determination of compliance. From your list of parameters cited in Table 2 only two have no corresponding EPA approved method: free and weak acid dissociable cyanide. You may continue analysis of these parameters at your own discretion, however, please be advised that ground water quality compliance relative to cyanide will be determined based on the results of the EPA approved total cyanide-colorimetric method (EPA Method 335.3).

11. Sampling and Reporting Frequency - sampling and reporting shall be at least quarterly, based on the following schedule*:

Quarter	Date Due
January - March	April 30
April - June	July 30
July - September	October 30
October - December	December 30

* The Bureau reserves the right to modify said frequency.

LBM/kc
BARRICK